

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

In re Application of:

Hans-Jurgen Albrecht, et al.	)	Examiner: S.J. Cohen
	)	Group Art No.: 1793
Application No.: 10/554,274	)	
	)	Confirmation No.: 3094
Filed: September 13, 2006	)	
	)	
For: SOLDERING MATERIAL BASED ON Sn )	)	
Ag AND Cu	)	

Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

**SECOND DECLARATION UNDER 37 C.F.R. § 1.132**

Sir:

I, Malcolm E. Warwick, a citizen of the United Kingdom, residing at 7 Stanley Avenue, Chesham, Bucks, HP5 2JF, England, do hereby aver as follows:

1. I refer to paragraphs 1-4 of my Declaration under 37 C.F.R. § 1.132 dated November 22, 2010 for background information of my education and industrial experiences.

2. I have now studied an Office Action mailed February 1, 2011<sup>\*</sup> issued by the U.S. Patent and Trademark Office and two U.S. patent documents -- U.S. Patent Nos. 5,393,489 (Gonya et al.) ("the '489 patent") and 4,758,407 (Ballentine et al.) ("the '407 patent") -- cited in the Office Action against the pending claims. The Office Action alleges that Claims 3, 8, 9 and 26 are rendered obvious by the '489 patent in view of the '407 patent. However, in my view, based on the teachings in those U.S. patent documents, whether individually or in combination, these claims are not unpatentable.

3. As a review, I set forth a brief discussion of the invention described by the subject application, together with my understanding of the teachings of the cited U.S. patent documents, as one of ordinary skill in the art of metallurgy.

4. The present invention is defined for instance with reference to Claim 3, the first independent claim presented in the application under examination. As so set forth, a lead free soldering material is provided, which consists essentially of Sn (tin), 2 to 10 wt.% Ag (silver), Bi (bismuth), 1 to 3 wt.% Sb (antimony), 0.5 to 3 wt.% Cu (copper), and 0.05 to 0.3 wt.% Ni (nickel). Claim 3 also requires that the Sb:Bi wt.% ratio be

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<sup>\*</sup> In this Declaration, I only address the claim rejections dealing with patentability, and consequently the two U.S. patent documents cited in the Office Action in support thereof.

from 1:1.5-3. And with reference to Claim 26, the second independent claim presented in the application under examination, the present invention is defined as a lead free soldering material, which consists essentially of Sn (tin), 2 to 10 wt.% Ag (silver), 1 to 3 wt.% Bi (bismuth), 1 to 3 wt.% Sb (antimony), 0.5 to 3 wt.% Cu (copper), and 0.05 to 0.3 wt.% Ni (nickel).

5. The first of the two U.S. patent documents cited as references against the pending claims is the '489 patent. The '489 patent is directed to and claims a high solidus temperature, high service temperature, high strength multi-component solder alloy consisting of 93.5 to 94.0 weight % Sn, 2.5 to 3.0 weight % Ag, 1.0 to 2.0 weight % Bi, 1.0 to 2.0 weight % Sb, and 1.0 weight % Cu. The '489 patent speaks in the specification to alloys that contain various combinations of Bi and Sb to Sn/Ag, with some of which that contain Cu.

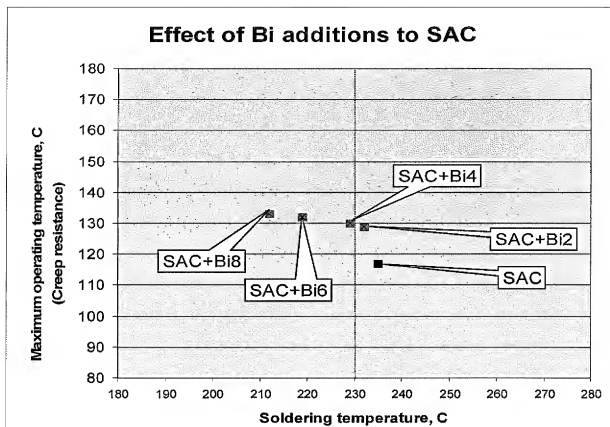
6. Reference to Fig. A below is helpful in understanding the impact of the addition of Bi to a SAC alloy. Fig. A shows that an addition of Bi to the SAC alloy appears to improve the operating temperature (in terms of creep resistance) and reduce the soldering process temperature.<sup>1</sup> More

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<sup>1</sup> The figures set forth in this Declaration are used in my Declaration under 37 C.F.R. § 1.132 dated November 22, 2010, but have been re-ordered and referenced to herein by way of letter for ease of discussion. Again, the

specifically, the addition of Bi at various levels to the SAC alloy shows that the creep resistance increases most significantly upon an initial addition of 2%, but then levels off with increased amounts of Bi. Someone skilled in the art, such as myself, would know that high levels of Bi could increase the risk of low melting temperature phases in the alloy. The low melting phases that may be created would be undesirable because they would tend to reduce reliability in fatigue under temperature cycling. All else being equal, this would discourage their use in demanding operating environments.

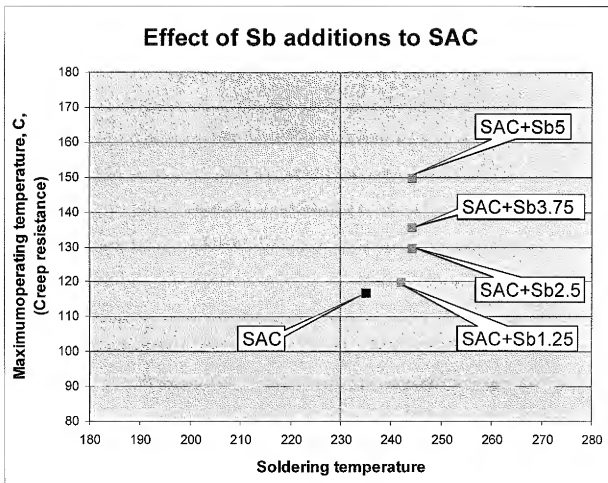
**FIG. A**



7. Reference to Fig. B below shows that an addition of Sb to the SAC alloy appears to improve the operating temperature (in terms of creep resistance) but at the expense of increased soldering process temperature. However, someone skilled in the art, such as myself, would know this occurrence to be an unacceptable compromise in physical properties. Materials used in the construction of circuit boards and electronic components are heat sensitive and higher temperatures increase physical failures (e.g., distortion, delamination etc.) and reductions in service reliability. Even small increases

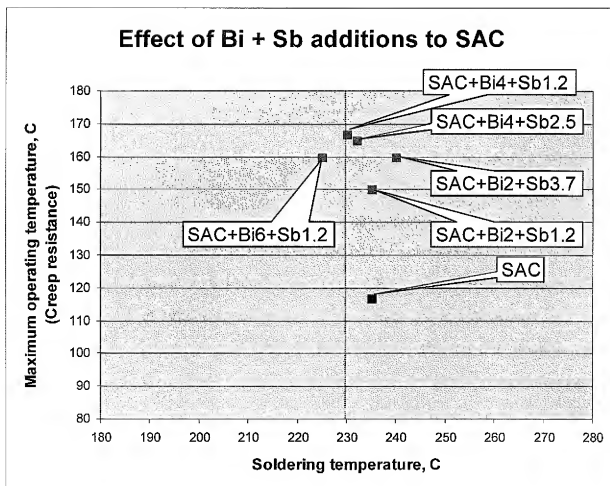
above the process temperature of the SAC alloy would be seen by someone of ordinary skill in the art, such as myself, as a reason to discount candidate alloys. This has been a major technical obstacle for the adoption in the industry of tin-rich alloys, including the SAC alloy, as a replacement for traditional tin-lead solders.

**FIG. B**



8. Reference to Fig. C below shows that an addition of Bi and Sb to the SAC alloy improves the operating temperature (in an additive fashion), but that the effect of Bi to lower the soldering process temperature is small compared with the effect of Sb in increasing it.

**FIG. C**



9. Based on the data presented in Figs. A-C, only a SAC alloy with a high Bi content and a relatively low Sb content

achieves an acceptable soldering process temperature. But such a SAC alloy would still not be suitable for demanding operating environments. These data would suggest to someone skilled in the art, such as myself, that SAC+Bi+Sb alloys as taught by the '489 patent would not be suitable to address the needs identified in the subject application, which are an alloy based on a SAC alloy that exhibits a comparatively low melting point while at the same time is designed for the highest possible usage temperatures of the solder joints being formed, particularly well-suited for microelectronic packaging and assembly applications.

10. The '407 patent is cited as secondary reference in combination with the '489 patent. As I have shown above, the '489 patent would not be suitable to address the needs identified in the subject application. The '407 patent does nothing to remedy the deficiencies of the '489 patent as a proper reference for citation in combination against the pending claims.

11. The '407 patent is directed to a variety of lead-free metal solder compositions. The compositions comprise, by weight:

A. 0.1-2.0% nickel, 3.0-5.0% copper, 4.0-6.0% antimony, 87.0-92.9% tin;



B. 0.1-0.5% silver, 0.1-2.0% nickel, 3.0-5.0% copper, 4.0-6.0% antimony and 87.0-92.9% tin;

C. 0.1-0.5% silver, 3.0-5.0% copper, 4.0-6.0% antimony and 87.0-92.9% tin;

D. 0.1-2.0%, nickel, 3.0-5.0% copper and 93.0-96.9% tin; or

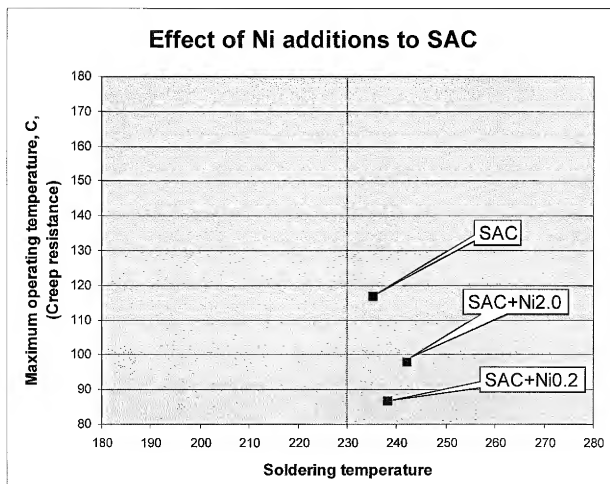
E. 0.1-0.5% silver, 0.1-2.0% nickel, 3.0-5.0% copper and 92.5%-96.8% tin.

12. The '407 patent teaches alloys which may be described in some embodiments as SAC+Ni (E) or SAC+Sb+Ni (B). The object of the '407 patent seems to me to be to create alloys with a wide melting range suitable for plumbing applications, specifically adding Ni to achieve this effect along with the high levels of Cu and Sb. Someone skilled in the art, such as myself, would understand that such alloys would not be considered suitable for microelectronic packaging and assembly processes since a wide melting range introduces processing problems for end-users.

13. Reference to Fig. D below shows that a Ni addition to the SAC alloy at a level of 0.2% and 2.0% has the effect of reducing the maximum operating temperature (in terms of creep resistance) and increasing the soldering process temperature. This shows that Ni additions have at best, minimal

effect, and what effect they do have on SAC alloy is to increase the soldering process temperature and/or reduce dramatically the operating temperature, neither of which is a particularly attractive feature. These data would suggest to someone skilled in the art, such as myself, that it would not be advantageous to add Ni to the SAC alloy.

**FIG. D**

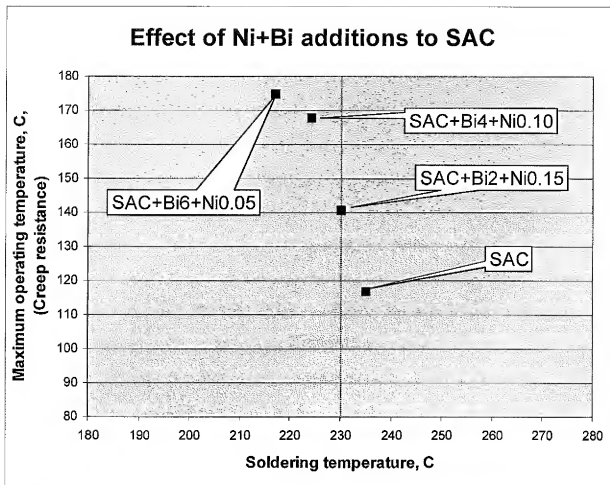


14. Further, adding Ni to tin-rich alloys raises a number of difficulties for the alloy manufacturer. For instance, dissolving Ni in a tin-rich alloy, such as the SAC alloy, requires that the melt be heated to higher temperatures than is necessary for the addition of, for example, Bi and Sb. Controlling the alloying process, particularly for relatively small additions of Ni within a tight tolerance range, requires close monitoring of melting and solidification and, where appropriate, the production of powder for solder pastes. Chemical analysis for Ni content in tin-rich alloys is also challenging, particularly from a quality control perspective. These factors add significant manufacturing costs to alloy production. Thus, taken together with the alloy performance data referred to above, someone skilled in the art, such as myself, would be discouraged in considering the addition of Ni to the SAC alloy, as the '407 patent would otherwise suggest.

15. Reference to Fig. E shows the impact that the combination of the addition of Ni and Bi has on the SAC alloy. The data illustrates the significant increase in maximum operating temperature (in terms of creep resistance) achieved by the addition of the combination of Ni and Bi to the SAC alloy. More specifically, Ni produces a marked improvement in operating temperature and a small reduction in soldering process

temperature. It was also surprising to observe a marked improvement in maximum operating temperature and a small reduction in soldering process temperature when Ni was added to an alloy of SAC+Bi+Sb. The result is that the synergistic effect of Bi+Ni raises the maximum operating temperature such that a relatively low level of Sb is required to further improve performance and only modest levels of Bi are required to counteract the effect of the Sb on the soldering process temperature. This avoids the negative effects of low melting temperature phases (due to excessive Bi) and high processing temperatures (due to excessive Sb).

FIG. E

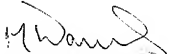


16. Accordingly, based on my experience and on my study of the materials referred to herein, in my view the invention as presently claimed, such as in Claims 3 or 26, is not rendered obvious over the combination of the '489 patent and the '407 patent cited in the Action.

17. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information or belief are believed to be true; and further that

these statements were made with the knowledge that willful false statements are like so made are punishable by fine or imprisonment or both under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Dated: 22/June/11

By:   
Malcolm E. Warwick